

# Some Snake Food Records from the Carolinas

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**ABSTRACT.** — Some 690 food items were recovered from digestive tracts of 479 snakes of 32 species from North and South Carolina. The most extensive series were from the colubrids *Regina septemvittata*, which contained only crayfish; *Virginia striatula*, which fed exclusively on earthworms; *Coluber constrictor*, whose diet was varied; *Ophedrys aestivus*, which contained mostly lepidoptera larvae, plus orthoptera and arachnids; *Elaphe obsoleta*, which consumed small mammals, young birds, and birds' eggs; and the crotalid, *Agkistrodon contortrix*, which contained mostly small mammals and lepidoptera larvae. Comments made by other authors anent secondary ingestion and lengthy retention of indigestible residues are questioned.

## INTRODUCTION

Studies of the food habits of snakes from the Carolinas, or closely adjacent areas, include those of Uhler et al. (1939), Hamilton and Pollack (1955, 1956), Savage (1967), and Garton and Dimmick (1969). Similar studies in other areas are those of Raney and Roecker (1947), Allen and Swindell (1948), Clark (1949), Carpenter (1952), Barbour (1956), Brown (1958), Klimstra (1959a,b), Bush (1959), Fitch (1960, 1963a,b), Burkett (1966) and Wharton (1969). Wright and Bishop (1915) included some food notes in their Okefenokee work.

This paper provides information on 690 food items from 479 snakes of 32 species, all from North and South Carolina. For better or worse, all common and scientific names used here for reptiles and amphibians are those provided in Collins et al. (1978).

## MATERIALS AND METHODS

A great many of the snakes were road-kills, but many also were secured alive. The presence of food in live specimens could usually be detected by palpation, and it could then be removed by manual manipulation. Dead specimens required dissection. Specimens with empty stomachs are not reported. Emphasis has purposely been placed upon the taking of certain food items rather than upon the volume of such items, especially when many small items of relatively similar size were involved.

## RESULTS

*Nerodia erythrogaster erythrogaster*, Redbelly Water Snake.

Five stomachs of this species contained 12 food items: 10 amphibians (6 undetermined tadpoles, 4 *Bufo terrestris*); and 2 fish (a *Micropterus salmoides* and a "sunfish").

Snakes involved were from Columbus Co., NC, and Horry and Sumter cos., SC.

*Nerodia sipedon sipedon*, Northern Water Snake.

Specimens were mostly from a number of sandy-bottomed, channelized streams of the North Carolina Piedmont and several mountain streams in the northwestern corner of the state. Food habits in lacustrine habitats might differ.

Forty-five items were recorded from 30 stomachs: 17 anurans (6 *Bufo w. fowleri*, 3 *Hyla chrysoscelis*, 3 *Scaphiopus holbrooki*, 2 *Rana catesbeiana*, 1 *Hyla crucifer*, 1 *Rana sphenoccephala*, and 1 undetermined); 17 salamanders (5 undetermined larvae, 4 *Desmognathus fuscus*, 2 larvae of *Pseudotriton* sp., 1 *Eurycea bislineata wilderae*, 1 *Plethodon glutinosus*, 4 undetermined); and 11 fish (5 *Semotilus atromaculatus*, 1 *Etheostoma* sp., 1 *Ictalurus* sp., 1 *Hypentelium nigricans*, 1 "sunfish," 2 undetermined).

I was surprised at the prominence of amphibians (75.6 percent of all items), and initially felt that this might correlate with the limited fish life in the channelized streams. However, 15 of the 19 food items from the unchannelized mountain streams were amphibians. Two of the larger snakes had eaten *Rana catesbeiana* with displacement volumes of 110 and 135 ml. Three of the largest meals taken represented 26, 40 and 56 percent of the weight of the respective snakes.

Specimens were from Alleghany, Ashe, Cabarrus, Caldwell, Lincoln, Mecklenburg, and Watauga cos., NC.

*Nerodia fasciata fasciata*, Banded Water Snake.

Twelve stomachs of this Coastal Plain form contained 20 food items: 12 frogs and toads (6 *Bufo terrestris*, 3 *Hyla gratiosa*, 1 *Hyla chrysoscelis*, 2 undetermined); 4 salamanders (2 *Desmognathus auriculatus*, 1 *Necturus punctatus*, 1 undetermined); and 4 fish (3 *Fundulus* sp., 1 undetermined). This species has been observed eating dead anurans on the highway on a rainy June night in Brunswick County, North Carolina.

Snakes examined were from Brunswick, Carteret, Craven and Columbus cos., NC, and Chesterfield and Sumter cos., SC.

*Regina septemvittata*, Queen Snake.

Raney and Roecker (1947), reporting on 45 stomachs from Erie County, New York, found crayfish in 44 and a dragonfly nymph in each

of 2. Wood (1949) reported the contents of 6 Ohio stomachs and 43 disgorgings as all crayfish, except for a single catfish. He further proposed that crayfish, either dead or alive, are probably taken in the soft-shelled condition following molting. My material supports these observations. Thirty-two stomachs contained remains of 35 crayfish, and fecal samples from 31 additional snakes contained gastroliths from 49 crayfish. The crayfish found in many stomachs appeared to have been soft-shelled, but, in a few instances, I could not be certain of this. The fecal gastroliths presumably were from crayfish at, or extremely close to, the molting state.

The majority of crayfish were small to medium in size, but several were relatively large. One first-year snake had eaten a very small crayfish, 20 mm total length (TL). However, a 32 cm TL snake, probably in its second year, contained a crayfish of 50 mm TL. No more than two crayfish were found in any stomach. Three of 31 fecal samples contained gastroliths from three crayfish. Of 24 crayfish whose orientation was noted, 15 had been swallowed head-first, 9 tail-first.

Specimens were from Alexander, Alleghany, Ashe, Buncombe, Catawba, Guilford, Iredell, Mecklenburg, Transylvania, Watauga and Wilkes cos., NC.

*Seminatrix pygaea paludis*, Carolina Swamp Snake.

Only four specimens, all from Brunswick County, North Carolina, contained food. Two had earthworm remains; a third had a very small fish (not over 20 mm TL), partly digested and unidentified; and the fourth contained fragments of a small, unidentified arthropod.

*Storeria dekayi*, Brown Snake.

Eight stomachs, from Columbus, Mecklenburg and Rowan counties, North Carolina, contained 5 earthworms and 4 small slugs.

*Storeria occipitomaculata occipitomaculata*, Northern Redbelly Snake.

Two stomachs, from Cabarrus and Columbus counties, North Carolina, yielded three very small (0.1 ml volume) slugs.

*Thamnophis sirtalis sirtalis*, Eastern Garter Snake.

Fourteen stomachs contained 16 food items: 8 salamanders (including *Pseudotriton* sp., *Plethodon glutinosus*, *Ambystoma opacum*, *Eurycyba bislineata*, 3 undetermined); 6 anurans (1 *Bufo quercicus*, 1 *Bufo w. fowleri*, 1 *Hyla chrysocelis*, 1 *Rana palustris*, 2 undetermined); and 2 earthworms (found in 2 of 5 snakes from the mountains). One snake was observed eating small, dead frogs on a highway in Brunswick County, North Carolina, on a rainy June night.

Snakes examined were from Brunswick, Columbus, Davidson, Jackson, Mecklenburg and Watauga cos., NC, and Hampton Co., SC.

*Thamnophis sauritus sauritus*, Eastern Ribbon Snake.

Thirteen stomachs yielded 14 relatively small amphibians: 11 anurans (3 *Acris gryllus*, 2 *Pseudacris triseriata feriarum*, 1 *Pseudacris brimleyi*, 2 *Hyla femoralis*, 1 *Hyla* sp., 1 just-metamorphosed *Rana catesbeiana*, 1 *Bufo* sp.); and 3 salamanders (2 *Desmognathus fuscus*, 1 *Eurycea bislineata*).

Snakes examined were from Ashe, Brunswick, Cabarrus, Jones and Mecklenburg cos., NC and Colleton and Lee cos., SC.

*Virginia striatula*, Rough Earth Snake.

Forty specimens contained only remains of earthworms. In 15 of these specimens the evidence consisted of dark, earthy material, plus setae in the intestine.

Snakes were from Brunswick, Columbus, Duplin, Guilford, Mecklenburg and Rowan cos., NC.

*Virginia valeriae valeriae*, Eastern Earth Snake.

Two of seven specimens examined contained only earthworm remains. The snakes were from Mecklenburg Co., NC, and Kershaw Co., SC.

*Heterodon platyrhinos*, Eastern Hognose Snake.

Toads were the only food I found in this snake. Five stomachs, all from Mecklenburg County, North Carolina, contained 6 *Bufo woodhousei fowleri*. One snake, 40 cm TL and weighing 26 gm, had just swallowed a toad weighing 29 gm, a truly gigantic meal.

*Diadophis punctatus*, Ringneck Snake.

These snakes feed largely upon small, slender-bodied prey, difficult to detect by palpation. Twelve stomachs contained 12 food items: 9 salamanders (3 *Plethodon jordani* "metcalfi", 1 *P. cinereus*, 1 *P. glutinosus*, 1 *Eurycea quadridigitata*, 3 undetermined); and 3 earthworms. All stomachs (8) from the mountain region contained salamanders; the earthworms were in 3 of 4 Coastal Plain snakes. One mountain specimen contained a small lepidoptera larva (phalaenid = "noctuid") along with a salamander. The salamander might have disgorged the insect larva, but I could not be certain of this.

Specimens were from Alexander, Avery, Caldwell, Columbus, Duplin, Macon, and Watauga cos., NC, and Dorchester Co., SC.

*Carphophis amoenus amoenus*, Eastern Worm Snake.

Seven stomachs yielded only earthworms; 16 others had dark, earthy material and earthworm setae in the intestines.



Snakes examined were from Caldwell, Columbus, Duplin, Mecklenburg and Stanly cos., NC.

*Farancia erythrogramma erythrogramma*, Rainbow Snake.

In late April in Sumter County, South Carolina, a snake (86 cm TL) was found at night laboriously attempting to swallow a mammoth tadpole of *Rana heckscheri* which it had dragged some 3 m up the bank of a pond.

*Coluber constrictor constrictor*, Northern Black Racer.

The food of this snake is quite diverse. A series of 86 items from 53 stomachs included reptiles, mammals, amphibians, arthropods, birds and a small snail, in that order of frequency and apparently all taken independently. There was great variation in size of animal taken, from a fairly large vole or snake to a small lepidoptera larva or lycosid spider. Reptiles and mammals ranked almost equally in bulk and, with amphibians, comprised 80 percent of the food items and 95.4 percent of volume. The 38 reptiles included: 22 lizards (9 *Scincella lateralis*, 5 *Eumeces* sp., 2 *Ophisaurus* sp., 2 *Anolis carolinensis*, 1 *Sceloporus undulatus*, 1 *Cnemidophorus sexlineatus*, 2 undetermined); 15 snakes (5 *Carphophis amoenus*, 3 *Opheodrys aestivus*, 2 *Nerodia fasciata*, 1 *Coluber constrictor*, 1 *Tantilla coronata*, 1 *Virginia striatula*, 1 undetermined, and a fragment of shed skin); and 1 young *Kinosternon subrubrum*. The 15 mammals included: 3 *Microtus pinetorum* (adult and young), 1 *Microtus pennsylvanicus* (young), 4 *Peromyscus leucopus* (mostly young), 1 *Sigmodon hispidus*, 1 *Mus musculus* and 5 undetermined. The 16 amphibians included: 6 *Acris gryllus*, 1 *Rana sphenoccephala*, 1 *Rana virgatipes*, 2 just-metamorphosed *Rana catesbeiana*, 2 *Hyla chrysoscelis*, 2 undetermined frogs and 2 *Desmognathus fuscus*. While arthropods made up 15 percent of the items, their bulk was very limited (1.3 percent of volume). They included 7 lepidoptera larvae, 3 lycosid spiders, 2 moths and 1 diptera larva. Remains of a small, unidentified bird occurred in each of three stomachs (2.9 percent of volume). At least two of these were nestlings.

Sixty-four percent of the stomachs contained a single food item, but one contained seven small frogs (mostly *Acris*), another had two young mice and two *Desmognathus fuscus*, and a third, collected on an April morning, had three very fresh *Carphophis amoenus*. On a morning in early May, a 110 cm TL male racer was found vigorously swallowing a 50 cm TL male of its own species. The hatchling eastern mud turtle found in a September specimen was still alive, and had been in the snake's stomach for at least two hours.

Snakes examined were from Brunswick, Cabarrus, Chatham, Columbus, Guilford, Iredell, Lincoln, Mecklenburg, Montgomery, Moore,

Richmond, Rowan, Rutherford and Watauga cos., NC, and Abbeville, Barnwell, Berkeley, Charleston, Dorchester, Horry, Kershaw, Lancaster, Marlboro and Sumter cos., SC.

*Masticophis flagellum flagellum*. Eastern Coachwhip.

Sixteen food items were recovered from 12 stomachs: 8 reptiles (6 *Cnemidophorus sexlineatus*, 1 *Eumeces* sp., 1 35 mm CL *Chrysemys concinna*); 5 mammals (1 *Peromyscus* sp. 4 undetermined); and 3 arthropods (2 cicada nymphs and 1 large *Amblyomma tuberculatum*, a tick). Both cicada nymphs were in a small snake from Charleston County, South Carolina. The tick, in the stomach of a larger snake, was 27 mm long and engorged with blood. Cooney and Hays (1972) regard this tick as host specific in the adult and nymphal stages to the tortoise, *Gopherus polyphemus*, and they believe it to be the largest tick in the United States, possibly the largest known. (A number of non-engorged ticks were collected from a large tortoise that was intercepted nearby.) The snake involved was found in a shallow Gopher tortoise burrow in Jasper County, South Carolina, along with specimens of *Bufo terrestris*. However, neither this snake nor another found in a similar situation had taken a toad.

Snakes examined were from Cumberland and Hoke cos., NC, and Charleston, Chester, Chesterfield, Edgefield, Jasper, Kershaw, Lexington, McCormick and Sumter cos., SC.

*Opheodrys aestivus*, Rough Green Snake.

This snake is partial to insect and arachnid prey. Fifty-nine stomachs contained 125 food items, mostly of three major groupings: lepidoptera (59.2 percent of items: 2 moths, 72 larvae); orthoptera (17.6 percent of items: 15 grasshoppers, 4 field and tree crickets, 2 mantids, 1 undetermined); and arachnids (13.6 percent of items: 12 spiders, 1 spider egg cocoon, 4 phalangids). One tiger beetle, 5 undetermined insects and 4 small snails were also present. Lepidoptera occurred almost twice as frequently as both the other major groups combined and larvae of phalaenids, hesperiids, geometrids, nymphalids and sphingids were recognized. One was only 10 mm in length. Recognizable spiders included lycosids, araneids and attids. Stomachs contained from one to eight food items.

These snakes were collected from April to October, with 59 percent taken during June, July and August. They were from Alexander, Brunswick, Chatham, Columbus, Craven, Guilford, Iredell, Mecklenburg, Richmond and Rowan cos., NC, and Berkeley, Colleton, Dillon, Horry and Sumter cos., SC.

*Elaphe guttata guttata*, Corn Snake

Ten food-laden specimens of this largely Coastal Plain form were encountered. They yielded 10 food items: 9 mammals (3 *Microtus*

*pennsylvanicus*, 2 *Peromyscus* sp., 1 *Oryzomys palustris*, 3 undetermined remains); and 1 unidentified bird.

Snakes examined were from Brunswick and Columbus cos., NC, and Colleton, Dorchester, Horry and Sumter cos., SC.

*Elaphe obsoleta obsoleta*, Black Rat Snake.

Thirty-nine stomachs yielded 51 food items, including four sets of eggs counted as single items. This snake appears to feed mainly on small mammals and young birds. Mammals comprised 59 percent of the food items (64 percent of volume) in this sample, and birds 37 percent of the items (34 percent of volume). Half of the 30 mammals were *Microtus* sp. (9) and *Peromyscus* sp. (6). Others were: 2 young *Rattus norvegicus* (one of 27 cm TL, the other smaller), 2 *Tamias striatus*, 2 *Condylura cristata*, 2 *Sigmodon hispidus*, 1 *Mus musculus*, 1 *Glaucomys volans*, 1 *Blarina brevicauda carolinensis*, 1 *Sciurus carolinensis* (tail only), 1 young *Sylvilagus floridanus* and 2 undetermined.

One snake contained remains of two hen eggs, another had two Carolina Wren eggs, and one from the mountains had swallowed ten Ruffed Grouse eggs. Recognizable young birds from other snakes included: American Robin, Cardinal, Yellow-breasted Chat, three Blue Jays and a hatchling Bobwhite. In nine other cases bird remains found were not identifiable.

One specimen had eaten a group of six adherent snake eggs, whose size, shape, number and other features suggested the possibility of *Lampropeltis getulus*. A first-year snake weighing 12 gm contained a *Sceloporus undulatus*.

Six snakes had taken unusually large meals that ranged from 24 to 46 percent (average 36 percent) of the weight of the snake.

Snakes examined were from Anson, Ashe, Burke, Cabarrus, Caldwell, Iredell, McDowell, Mecklenburg, Montgomery, Stanly, Stokes, Watauga and Wilkes cos. NC, and Aiken Co., SC.

*Elaphe obsoleta quadrivittata*, Yellow Rat Snake.

Food was found in two specimens from Berkeley and Horry counties, South Carolina: a young rabbit weighing 140 gm; and fragments of several pale blue eggs, possibly those of an Eastern Bluebird.

*Pituophis melanoleucus melanoleucus*, Northern Pine Snake.

A single, medium-sized specimen, road-killed in late June in Richmond County, North Carolina, contained four Bobwhite eggs.

*Lampropeltis getulus getulus*, Eastern Kingsnake.

Eight stomachs yielded eight food items: 5 reptiles (1 *Ophisaurus attenuatus*, 2 *Ophedrys aestivus*, 1 *Diadophis punctatus*, 1 large *Lampropeltis*

*calligaster rhombomaculata*); 2 turtle eggs, from two specimens collected in late May and mid-June; and a decaying post-nestling Mockingbird known to have been eaten as carrion.

Snakes examined were from Carteret, Columbus, Mecklenburg and Surry cos., NC, and Colleton, Orangeburg and Williamsburg cos., SC.

*Lampropeltis triangulum elapsoides*, Scarlet Kingsnake.

Two snakes, from Berkeley and Sumter counties, South Carolina, contained three specimens of the lizard, *Scincella lateralis*.

*Lampropeltis calligaster rhombomaculata*, Mole Kingsnake.

Six stomachs yielded 12 food items: 11 small mammals (1 adult *Microtus pinetorum*, 10 young *Microtus pennsylvanicus*, 1 undetermined); and 1 snake (*Ophedrys aestivus*). One snake had taken three young meadow voles which, from their sizes, were clearly from two different litters. The largest meal, five young meadow voles, had been taken by an egg-laden female snake in early May.

Snakes were from Mecklenburg and Rowan cos., NC, and Spartanburg Co., SC.

*Cemophora coccinea copei*, Northern Scarlet Snake.

Some early literature statements regarding food of *Cemophora* are rather vague. Dickson (1948) first noted this snake's feeding on reptile eggs, and contributions by Neill (1951), Minton and Bechtel (1958) and Palmer and Tregembo (1970) also focused on this topic.

Most *Cemophora* that I examined did not contain food. A specimen from Moore County, North Carolina, taken in late July, contained remains of three small snake eggs (possibly *Diadophis*). An individual from Brunswick County, collected in late May, had swallowed two small eggs, apparently of a snake. A specimen collected in mid-June in Sumter County, South Carolina, contained a collapsed egg "shell" 8 mm long, evidently of *Scincella lateralis*. It was far down in the intestine and apparently was going to pass through the gut undigested. This snake has been cornered in a sunken cistern and partly swallowed, tail first, by a large *Bufo terrestris*. The intestines of several snakes contained one or more small masses of sandy or earthy material, but these masses did not include earthworm setae. The stomachs of one or two of my early snakes contained pale, yellow, fluid material. When I later saw Dickson's (1948) note, I realized this might have been ingested egg material.

*Tantilla coronata*, Southeastern Crowned Snake.

Five snakes contained remains of five small centipedes and two small beetle larvae of cucujoid type.



Snakes examined were from Alexander and Cabarrus cos., NC, and Richland Co., SC.

*Micrurus fulvius fulvius*, Eastern Coral Snake.

The intestine of a single specimen for Aiken County, South Carolina, contained smooth scales of a snake.

*Agkistrodon contortrix*, Copperhead.

A series of 35 stomachs yielded 62 items, chiefly small mammals and larvae of lepidoptera. Mammal remains ranked first in volume (59.2 percent) but second as percentage of total food items (37.1). Among the remains of 23 mammals, those identifiable were: 5 *Peromyscus* sp., 4 *Microtus pennsylvanicus*, 1 *Microtus pinetorum*, 1 *Zapus hudsonius*, 1 *Reithrodontomys humulis* and 1 *Blarina brevicauda carolinensis*. Insects ranked second in volume (24.9 percent) and first in percentage of food items (56.5). They included 33 larvae of lepidoptera, 1 cicada nymph and 1 adult dragonfly. The relative prominence of these larvae is due partly to one large copperhead's having taken 20 specimens of *Anisota senatoria* (Citheroniidae). This caterpillar occurred also in four other stomachs. Another snake had eaten two large saturniid moth larvae. Eight of the nine specimens that contained larvae were collected in September or October. The presence of a fresh adult dragonfly in one stomach was surprising. In the caudal end of the same stomach was mouse-colored fur of some small mammal that apparently had been eaten much earlier. James D. Brown has given me verbal permission to report that each of three snakes whose remains he examined in northern Craven County, North Carolina, in September, 1975, contained a large milliped, apparently of "*Spirobolus*" type (*Narceus*).

Three of my specimens contained reptiles (6.9/4.8 percent): 1 *Carphophis amoenus*, 1 *Diadophis punctatus* and 1 *Ophisaurus* sp. Both snakes had been eaten by copperheads in their first year of life. Remains of a young bird, possibly a Rufous-sided Towhee or Blue Grosbeak, were found in another stomach.

Two copperheads had taken especially sizable meals, 36 and 62 percent of their weights. In only five cases out of the 35 did stomachs contain more than one food item.

Snakes examined were from Anson, Brunswick, Burke, Caldwell, Columbus, Mecklenburg and Robeson cos., NC, and Colleton, Dillon and Horry cos., SC.

*Agkistrodon piscivorus piscivorus*, Eastern Cottonmouth.

Three specimens, from Horry and Berkeley counties, South Carolina, contained food. A 395 mm TL snake had a small frog of the genus *Rana*,

and a 600 mm TL specimen contained a shrew, *Cryptotis parva*. The intestine of a 380 mm TL specimen contained mammal fur and smooth snake scales.

*Crotalus horridus*, Timber Rattlesnake.

Three specimens from Alleghany and Buncombe counties, North Carolina, had eaten four mammals: 2 *Microtus pennsylvanicus*, 1 *Tamias striatus* and 1 *Ochrotomys nuttalli*.

Two young snakes, of what may or may not be recognized as the subspecies *C. h. atricaudatus*, contained a young *Peromyscus* sp. and a *Microtus pennsylvanicus*. A larger snake, 140 cm TL, had eaten a *Sciurus carolinensis*. These last snakes were from Brunswick and Burke cos., NC, and Chesterfield Co., SC.

## DISCUSSION

Neill and Allen (1956) commented rather vigorously and dogmatically concerning "secondarily ingested food items" in snake stomachs. Their warning was valid, but their paper, which considerably overstated the case, is still being quoted uncritically. It is evident that some early workers, e.g. Surface (1906), made no effort to distinguish between primary, and possible secondary, items. No doubt there have been occasional oversights and misinterpretations since those times. However, to imply that a copperhead or black racer (among others) may not take arthropods at times seems extremely questionable, if not actually absurd. Savage (1967) recorded 29 cicadas in 42 copperheads from the Great Smokies region, and his study apparently did not include a season of periodical cicada emergence. The finding of centipedes in southern *Sistrurus* by Hamilton and Pollack (1955) probably should have suggested to the rest of us that we know too little about that snake. Although it involves a totally different small viper, a figure in Copeia (1967, p. 224) is thought provoking in this connection.

Heavier skeletal parts of some beetles are, of course, highly resistant to digestion by snakes. However, softer materials (e.g. moths; caterpillars; cicada nymphs; abdominal regions of spiders and of mantids and other orthoptera; small centipedes) appear to pose no appreciable problem.

Neill and Allen (1956) also referred to lengthy retention of indigestible food residue in the colon of such large snakes as *Python* and *Eunectes*. I may not be qualified to comment on this, since my chief experience has been with small, eastern forms, especially *Nerodia*. However, as I showed in a later paper on water snake food (Brown 1958), such retention occurs when a snake is without food for an extended period. A meal, or sometimes even a massive drink of water, may stimulate it to pass such

previous residue. A specimen that was feeding regularly and frequently would pass all residue through without appreciable delay. This feature, using a "marker" meal, was found to be useful in roughly gauging "total digestive time" at average summer temperatures. The later ingestion of a "chaser" meal helps to ensure that the marker meal does not dally along the way. The observer, of course, must experiment a bit to see whether the marker material is all being voided at one time.

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